CORPORATE FORECASTING

AN ECONOMETRIC MODEL OF THE EDMONTON DOWNTOWN OFFICE SPACE MARKET

Research Paper No. 8

THE CITY OF Edmonton PLANNING AND BUILDING

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AN ECONOMETRIC MODEL OF THE EDMONTON DOWNTOWN OFFICE SPACE MARKET

by
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This Technical Paper has been prepared by the Corporate Forecasting Group, Long Range Planning Branch, Planning and Building Department. This paper documents research results as part of an ongoing forecasting activity. Neither the methods nor the results have been endorsed by the City of Edmonton.

October, 1986

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ACKNOWLEDGMENTS

We wish to express our thanks to Edward Egyedy and Harvey Crone for reviewing earlier drafts and offering useful comments and suggestions.

Our thanks are also due to the Word Processing Centre of the Planning and Building Department for their typing of this report.

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1. INTRODUCTION

Over the past ten years, the Edmonton downtown office space market has become increasingly volatile. Vacancy rates have increased substantially from a low of 3.1% in 1979 to a high of 24.8% in 1983. Construction of new office space has fallen from a high of 1.369 million square feet in 1977 to a net loss of office space in 1984, while absorption of office space has fluctuated from a high of 1.040 million square feet in 1981 to a negative absorption figure in 1982.

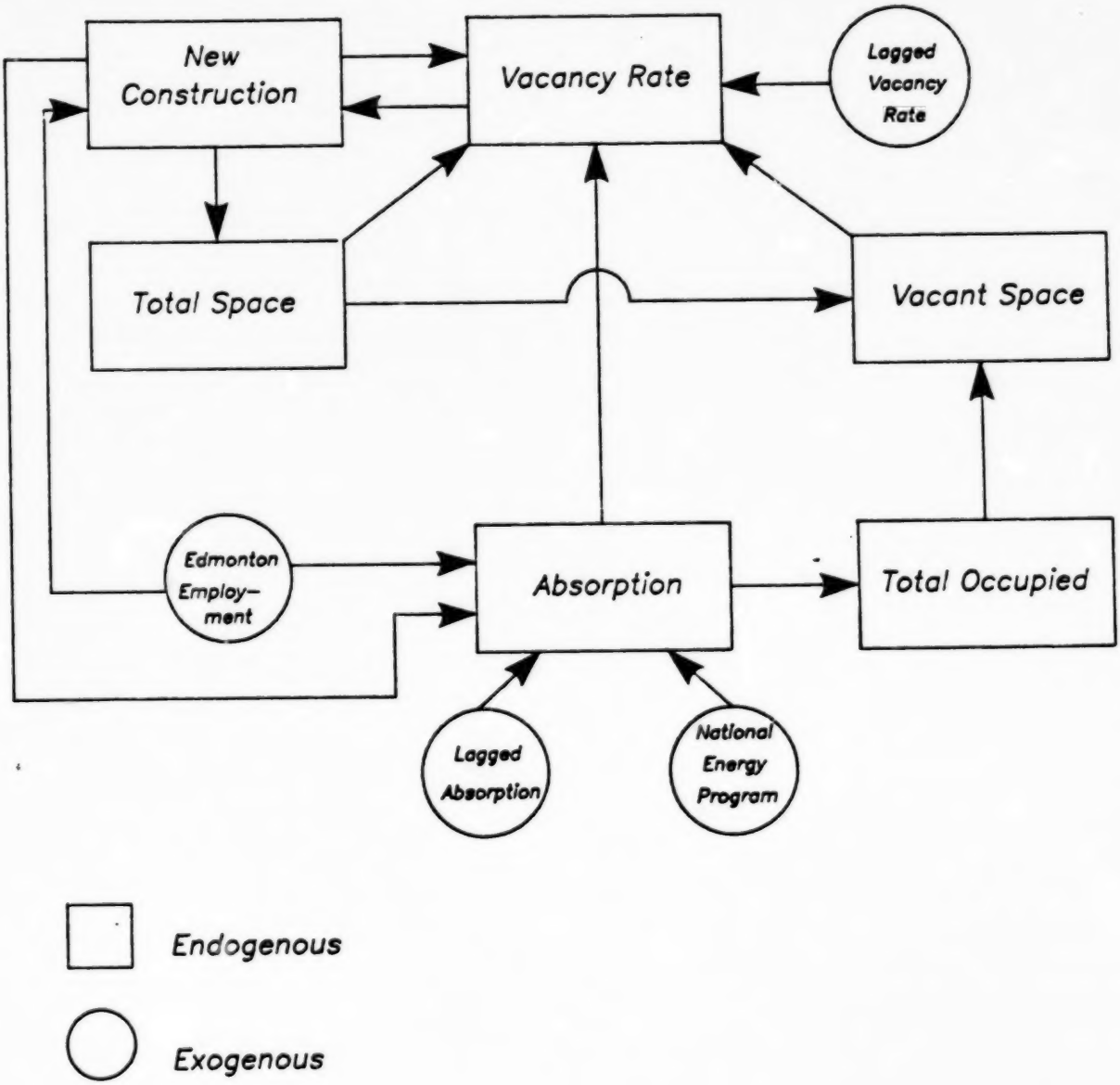
The purpose of this report is to undertake an econometric analysis of the Edmonton downtown office space market. The report is intended to be used as a component of a larger project entitled An Econometric Model of the Edmonton Economy. This analysis is based on a theoretical model that consists of seven equations which describe the various components of the Edmonton downtown office space market. The interaction among the components is illustrated in Figure 1.

Section 2 describes the seven equations used in the model. Three equations are structural equations describing the relationships between socio-economic variables and new office construction, office space absorption and office vacancy rates. The other four equations are definitional equations. The structural equations are tested and estimated in Section 3, using the ordinary least squares technique and data for the period 1971 to 1985. In Section 4 the model is simulated to provide forecast values for each of the components of the office space market for the period 1986 to 1991.

2. THE THEORETICAL MODEL

This section describes the equations used in the model and the theoretical relationship between the endogenous variable and each of the explanatory variables in the equation.

Figure 1
Edmonton Downtown Office Space Market Flow Chart



2.1 Net New Construction

Net new construction of office space is expected to be influenced by a number of variables such as the previous year's office vacancy rates, the amount of net new construction in the previous year and employment levels. The expected relationship between new construction and these variables is shown below:

$$NC = N(VRL2, NCL1, EMP);$$

$$\text{with } N'_{VRL2} < 0,\ N'_{NCL1} < 0,\ N'_{EMP} > 0$$

Where:

NC = Net new office construction
VRL2 = Office vacancy rate lagged two years
NCL1 = Net new construction in the previous year
EMP = Edmonton employment

Office vacancy rates in previous years are expected to influence the current year's level of net new construction. When office vacancy rates are high, little new office construction is likely to occur so that the expected relationship between net new construction and vacancy rates is negative. Previous levels of construction activity are expected to influence net new construction activity this year. High levels of construction activity in previous years are likely to lead to reduced levels in the current year and vice versa. An increasing work force is assumed to place more demand for new office space, and therefore, a positive relationship is expected between employment levels and net new construction.

2.2 Total Space

Total space is equal to total space in the previous year plus net new construction in the current year, that is,

$$TS = TSL1 + NC$$

Where:

TS = Total office space
TSL1 = Total office space in the previous year
NC = Net office construction

2.3 Office Space Absorption

Variables that are assumed to influence office space absorption include employment, the National Energy Program, new office space construction and the previous year's absorption of office space. The expected relationship between office space absorption and these variables is shown below:

$$ABS = A(EMP, NEP, NCL1, ABSL1);$$

with $A'_{EMP} > 0$, $A'_{NEP} < 0$, $A'_{NCL1} > 0$, $A'_{ABSL1} < 0$

Where:

ABS = Office space absorption
EMP = Edmonton employment
NEP = The National Energy Program
NCL1 = Net new construction in the previous year
ABSL1 = Office space absorption in the previous year

Employment is expected to have a positive relationship with office space absorption since any increase in the employment is likely to lead to an increase in demand for new office space absorption. The National Energy Program which lasted from 1982 to 1984, is expected to have a negative impact on office space absorption. New construction from the previous period is expected to have a positive relationship with office absorption since, for any office space absorption to occur, there must be enough supply of office space which is affected by net new construction. Last year's office space absorption is assumed to have a negative relationship with the present year's absorption, because as more absorption takes place in the previous year, there is likely less need for more space this year.

2.4 Total Occupied Office Space

Total occupied office space is calculated using the following formula:

$$TO = TOL1 + ABS$$

Where:

TO = Total occupied office space
TOL1 = Total occupied office space in the previous year
ABS = Office space absorption

2.5 Vacant Office Space

Vacant office space is calculated based on the following formula:

$$VS = TS - TO$$

Where:

VS = Vacant office space

TS = Total office space
TO = Total occupied office space

2.6 Vacant Office Rate

Office vacancy rates may be estimated using the following two methods.

2.6.1 Definitional Method

By definition, office vacancy rates are calculated based on the following formula:

$$VR = \frac{VS}{TS}$$

Where:

VR = Office vacancy rate
VS = Vacant office space
TS = Total office space

2.6.2 Functional Method

Office vacancy rates are assumed to be influenced by a number of variables such as net new construction, absorption rates and the previous year's office vacancy rates. The expected relationship between vacancy rates and these variables is shown below:

$$VR = V(VRL1, NC, ABS)$$

with $V'_{VRL1} > 0$, $V'_{NC} > 0$, $V'_{ABS} < 0$

Where:

VR = Office vacancy rate
VRL1 = Office vacancy rate in the previous period
NC = Net new office construction
ABS = Office space absorption

Last year's vacancy rate is expected to influence the current year's vacancy rate. The expected relationship between vacancy rates and the previous year's vacancy rate would be positive. Any new construction will add to the total amount of office space and therefore will increase office vacancy rates. The expected relationship between office vacancy rates and net new construction is positive. Any office space absorption is likely to lead to a reduction in the vacancy rate and a negative relationship between office vacancy rates and absorption is expected.

3. ESTIMATION OF THE MODEL

To test and estimate the coefficients of the structural equations described in Sections 2.1, 2.3 and 2.6.2, the ordinary least squares technique was used. All data used in the estimations are annual from 1971 to 1985. The estimated equations are shown below:

3.1 New Construction

(a) NC = -1001.416 -71.780 VRL2 -0.608 NCL1 + 8.392 EMP
(1.49) (3.06) (2.62) (3.04)

R^2 = .535 R^{-2} = .408 SEE = 433.7 DW = 2.13

Where:

NC = Net new construction, in thousands of square feet

VRL2 = Office vacancy rate lagged two years, in percent

NCL1 = Net new construction in the previous year, in thousands of square feet

EMP = Employment in Edmonton, in thousands of persons

Figures in parenthesis are Students' "t" statistics. The "t" test indicates that all explanatory variables are statistically significant at the 99% or higher level of confidence.

The above relationship also indicates that office vacancy rates for the previous period are the most significant factor affecting new office construction. Net new construction for the previous period and Edmonton employment levels are also significant in determining new office construction. The three variables used in the equation explain approximately 53.5% of new construction activity.

However, because of the low R^2 value, the structure of the above relationship was redefined and re-estimated, taking the natural logarithm value for the net new construction. This technique was used since a better relationship was found between the natural logarithm of new new office construction and the independent variables presented in the equation below.

(b) LNNC = -3.147 -0.486 VRL2 -0.0062 NCL1 +0.0515 EMP
(1.61) (7.11) (9.12) (6.41)

R^2 = .898 R^{-2} = .870 SEE = 1.262 DW = 2.03

Where:

LNNC = Natural logarithm of net new office space construction

VRL2 = Office vacancy rate lagged two years, in percent

NCL1 = Net new construction in the previous period, in thousands of square feet

EMP = Edmonton employment, in thousands of persons

The "t" statistics indicate that all explanatory variables are statistically significant at the 99% or higher level of confidence.

The above relationship also indicates that new office construction in the previous period is the most significant factor affecting new office construction. Vacancy rates lagged two years and employment levels are also significant in determining levels of new office construction. The three variables used in the equation explain approximately 89.8% of new construction activity.

3.2 Office Space Absorption

(a) ABS = -125.313 +2.807 EMP -992.451 NEP +0.217 NCL1 -0.311 ABSL1
(.36) (2.21) (5.02) (1.73) (1.71)

R^2 = .720 R^{-2} = 0.608 SEE = 231.41 DW = 1.92

Where:

ABS = Office space absorption, in thousands of square feet
EMP = Edmonton employment, in thousands of persons
NEP = National Energy Program
NCL1 = Net new construction in the previous year, in thousands of square feet
ABSL1 = Absorption in the previous year, in thousands of square feet

The "t" statistics indicate that all explanatory variables are statistically significant at the 90% or higher level of confidence.

The above relationship also indicates that the National Energy Program was the most important factor affecting Edmonton office space absorption. The other three variables are also very important. The four variables used in the equation explain approximately 72% of Edmonton's office space absorption between 1971 and 1985.

(b) LNABS = 3.64 +0.0152 EMP -9.01 NEP +0.003 NCL1 -0.0062 ABSL1
(2.58) (2.92) (11.14) (3.76) (8.36)

R^2 = .934 R^{-2} = .916 SEE = .947 DW = 2.03

Where:

LNABS = Natural logarithm of office space absorption
EMP = Edmonton employment, in thousands of persons
NEP = National Energy Program
NCL1 = Net new construction in the previous year, in thousands of square feet
ABSL1 = Absorption in the previous year, in thousands of square feet

The "t" statistics indicate that all explanatory variables are statistically significant at the 99% or higher level of confidence.

The above relationship also indicates the National Energy Program was the most important factor affecting Edmonton office space absorption, with the other three variables also being very important. The four variables used in the equation explain approximately 93% of Edmonton's office space absorption between 1971 and 1985.

3.3 Office Vacancy Rates

VR = 0.3374 +0.9300 VRL1 +0.0079 NC -0.0075 ABS
(0.29) (13.90) (8.83) (5.56)

R^2 = .961 R^2 = .951 SEE = 1.84 DW = 3.07

Where:

VR = Office vacancy rate, in percent
VRL1 = Office vacancy rate in the previous year, in percent

NC = Net new construction, in thousands of square feet

ABS = Office space absorption, in thousands of square feet

The "t" statistics indicate that all explanatory variables are statistically significant at the 99% or higher level of confidence.

The above relationship indicates that office vacancy rates for the previous period are the most important factor affecting current office vacancy rates. Also important are new office construction and absorption. The three variables used in the equation explain approximately 96% of Edmonton's office vacancy rate between 1971 and 1985.

4. MODEL SIMULATION

The estimated model was used to forecast for the components of the Edmonton downtown office space market. The forecast values of Edmonton employment levels used in the model simulation were taken from the "Socio-Economic Forecasts, 1986-1991", prepared by the City Forecast Committee (June 1986).

Equations 3.1(b) and 3.2(b) were not used in our simulation because of their extreme sensitivity involved in the conversion of the natural logarithm, despite their high R^2 values. Instead, Equations 3.1(a) and 3.2(a) were used. In order to generate more reasonable values, the constant terms of these two equations were modified. The revised complete model is presented below.

1. NC = -845 -71.780 VRL2 -0.608 NCL1 +8.392 EMP
2. TS = TSL1 +NC
3. ABS = -325 +2.807 EMP -992.451 NEP +0.217 NCL1 -0.311 ABSL1
4. TO = TOL1 +ABS
5. VS = TS - TO
6. $VR = \frac{VS}{TS}$

or, 6b. VR = 0.3374 +0.93 VRL1 +0.0079 NC - 0.0075 ABS

Where:

NC = Net new construction, in thousands of square feet
VRL2 = Office vacancy rate lagged two years, in percent
NCL1 = Net new construction in the previous year, in thousands of square feet
EMP = Employment in Edmonton, in thousands of persons
ABS = Office space absorption, in thousands of square feet
NEP = The National Energy Program
ABSL1 = Office space absorption in the previous year in thousands of square feet
TS = Total office space, in thousands of square feet
TSL1 = Total office space in the previous year, in thousands of square feet
TO = Total occupied office space, in thousands of square feet
VR = Office vacancy rate, in percent
VS = Vacant office space, in thousands of square feet

Results produced by the model for the period 1986-1991 are shown in Table 1. Office vacancy rates are forecast to decline from 18.1% in 1986 to a low of 15.2% in 1991. Throughout the same period, net new office space construction increases from 310,000 square feet in 1986 to 804,000 square feet in 1991, while office space absorption fluctuates from a low of 559,000 square feet in 1987 to a high of 714,000 square feet in 1991. Total office space in downtown Edmonton increases by 3,713,000 square feet between 1986 and 1991 for a total office floorspace of 17,099,000 square feet by 1991.

5. CONCLUSIONS

The theoretical model presented in this paper, and to be included in the econometric model of the Edmonton economy, describes the important factors and interactions in the Edmonton downtown office space market. Based on the results obtained from the model, office vacancy rates are

Table 1

EDMONTON DOWNTOWN OFFICE SPACE MARKET

(values in thousands of square feet)

Actual Values

Year	New Construction	Absorption	Vacancy Rate (%)	Vacancy Rate (%)	Total Space	Total Occupied	Vacant Space
1984	-269	160	22.0	22.0	12,984	10,133	2,851
1985	401	465	20.8	20.8	13,385	10,598	2,787

Forecast Values

Year	New Construction	Absorption	Vacancy Rate 1	Vacancy Rate 2	Total Space	Total Occupied	Vacant Space
1986	311	614	18.1	17.5	13,696	11,212	2,484
1987	485	559	17.0	16.3	14,181	11,771	2,409
1988	612	628	16.2	15.7	14,793	12,400	2,394
1989	676	654	15.6	15.4	15,469	13,054	2,415
1990	763	682	15.4	15.6	16,232	13,736	2,496
1991	818	715	15.2	16.0	17,049	14,451	2,598

Note: Vacancy Rate 1 is calculated using Equation 2.6.1
Vacancy Rate 2 is calculated using Equation 3.2

expected to decline to around 15.2% by 1991, while net new office construction and absorption levels are expected to increase gradually throughout the 1986-1991 period.

One of the major problems in building a model of the downtown office market is to forecast values which tend to be grouped into periods of high and low activity. Since office space is built or absorbed in large increments of hundreds of thousands of square feet, and the time to complete a project may take two to three years, all results presented in the model should be viewed as a trend that is expected to occur over the next five years rather than actual annual levels.

As new and revised data becomes available, attempts will be made to further refine the model. The impact of one or two large scale office developments will have serious repercussions on any results obtained from the model. Of particular importance to the model will be the addition of major new office projects such as Canada Place to be completed in 1987.

APPENDIX A

VARIABLE NAMES AND HISTORICAL DATA

1.	YEAR	Years 1971-1985
2.	NC	Net new office construction, in thousands of square feet
3.	VRL2	Office vacancy rate for the previous period, in thousands of square feet
4.	NCL1	Net new office construction for the previous period, in thousands of square feet
5.	EMP	Employment in Edmonton, in thousands of persons
6.	TS	Total office space, in thousands of square feet
7.	TSL1	Total office space in the previous year, in thousands of square feet
8.	ABS	Office space absorption, in thousands of square feet
9.	NEP	The National Energy Program
10.	ABSL1	Office space absorption in the previous year, in thousands of square feet
11.	TO	Total occupied office space in thousands of square feet
12.	TOL1	Total occupied office space in the previous year, in thousands of square feet
13.	VR	Office vacancy rate, in percent
14.	VS	Vacant office space, in thousands of square feet
15.	LNNC	Natural logarithm of net new office construction
16.	LNABS	Natural logarithm of office space absorption

YEAR	NC	VRL2	NCL1	EMP
1971	794.000	2.0	200.000	199
1972	0	2.0	794.000	194
1973	205.000	2.5	0	208
1974	718.000	1.1	205.000	233
1975	424.590	1.0	718.000	268
1976	666.000	3.4	424.590	278
1977	1,369.000	1.6	666.000	270
1978	33.000	2.4	1,369.000	290
1979	433.500	10.2	33.000	310
1980	1,289.717	6.2	433.500	332
1981	485.000	3.1	1,289.717	356
1982	932.053	8.7	485.000	347
1983	1,830.522	2.5	932.053	332
1984	-269.239	14.3	1,830.522	328
1985	400.551	24.8	-269.239	349

YEAR	TS	TSL1	ABS	NEP
1971	2,723.995	NA	853.500	0
1972	3,517.992	2,723.995	30.000	0
1973	3,517.992	3,517.992	208.500	0
1974	4,440.992	3,517.992	631.700	0
1975	4,865.482	4,440.992	477.100	0
1976	5,531.482	4,865.482	602.150	0
1977	6,900.482	5,531.482	798.200	0
1978	7,230.482	6,900.482	588.150	0
1979	7,663.982	7,230.482	643.900	0
1980	8,953.699	7,663.982	806.980	0
1981	9,438.699	8,953.699	1,040.261	0
1982	10,370.852	9,438.699	-317.774	1
1983	13,253.635	10,370.852	85.124	1
1984	12,984.397	13,253.635	160.252	1
1985	13,384.948	12,984.397	465.371	0

Source: Colliers, McCaulay, Nicolls Incorporated

YEAR	ABSL1	TO	TOL1	VR
1971	150.000	2,653.992	NA	2.5
1972	853.500	3,477.992	2,653.992	1.1
1973	30.000	3,481.492	3,477.992	1.0
1974	208.500	4,318.192	3,481.492	3.4
1975	631.700	4,795.192	4,318.192	1.6
1976	477.100	5,397.342	4,795.192	2.4
1977	602.150	6,195.542	5,397.342	10.2
1978	798.200	6,783.692	6,195.542	6.2
1979	588.150	7,427.592	6,783.692	3.1
1980	643.900	8,166.289	7,427.592	8.7
1981	806.980	9,206.550	8,166.289	2.5
1982	1,040.261	8,888.776	9,206.550	14.3
1983	-317.774	9,972.710	8,888.776	24.8
1984	85.124	10,132.962	9,972.710	22.0
1985	160.252	10,598.333	10,132.962	20.8

YEAR	VS	LNNC	LNABS
1971	70.000	6.67708	6.74935
1972	40.000	0.00000	3.40120
1973	36.500	5.32301	5.33994
1974	122.800	6.57647	6.44841
1975	70.290	6.05112	6.16773
1976	134.140	6.50129	6.40051
1977	704.940	7.22184	6.68236
1978	446.790	3.49651	6.37698
1979	236.390	6.07189	6.46754
1980	787.410	7.16218	6.69330
1981	232.149	6.18415	6.94723
1982	1,482.076	6.83739	-5.76130
1983	3,280.925	7.51236	4.44411
1984	2,851.435	-5.59560	5.07675
1985	2,786.615	5.99284	6.14283

Source: Colliers, McCaulay, Nicolls Incorporated